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GIS Application System Design Applied to Information Monitoring

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Abstract

Natural environment information management system involves on-line instrument monitoring, data communications, database establishment, information management software development and so on. Its core lies in collecting effective and reliable environmental information, increasing utilization rate and sharing degree of environment information by advanced information technology, and maximizingly providing timely and scientific foundation for environmental monitoring and management. This thesis adopts C# plug-in application development and uses a set of complete embedded GIS component libraries and tools libraries provided by GIS Engine to finish the core of plug-in GIS application framework, namely, the design and implementation of framework host program and each functional plug-in, as well as the design and implementation of plug-in GIS application framework platform. This thesis adopts the advantages of development technique of dynamic plug-in loading configuration, quickly establishes GIS application by visualized component collaborative modeling and realizes GIS application integration. The developed platform is applicable to any application integration related to GIS application (ESRI platform) and can be as basis development platform of GIS application development.

Keywords-information monitoring; GIS; plug-in; application framework

1. Introduction

With GIS development in the last 30 years, it is forming the integrated technology system and establishing its theory system, and it has formed multi-level and different-scales application patterns. With computers increasingly becoming the mainstream technology, people begin to adopt application framework theory to design software structure of more and more software. Application framework has been a widely used term, which has become a very practical and usual programming specification and

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efficiency and the reliability of products and reduce project development cost, many GIS secondary developers will organize its key programmer to develop a GIS application framework and encapsulate some general-purpose core functions. These frameworks may use different technologies and strategies, but their purposes are same: to reduce the workload of coding repeats, increase programming efficiency and provide project personnel with a favorable platform and workflow. Owning an extendible GIS application framework means that when application project developers do not need to set up a system from scratch when they receive a new project. They only need to inherit and extendibility develop their GIS application framework in one working mode, and use the previous developed results as much as possible to quickly build a functional module platform in UI layer or logical layer. Also the modules of the platform have natural reusability.

2. The development technology of plug-in GIS application framework

2.1 Summary of Plug-in development Technology

Plug-in technology divides the whole application program into host program and plug-in object in the process of software design and development. Host program can call plug-in object and plug-in object can realize its own logic in host program. Their interaction is based on a common communication contract. Host program can exist independently of plug-in object. Even though there is no plug-in object, host program can run without any influence. Therefore, we can add or adjust functions by adding or subtracting or modifying plug-ins by avoiding changing host program.

As for lots of professional software, using plug-in framework mechanism to develop application software is an inevitable choice. As for any software, no matter how detailed investigation on users and demand analysis made by project developer before developing are, it can not meet all used requirements of every industry and every user. To extend the life cycle of software products, under the circumstance that do not modify software grogram body, if software can “grow” according to users’ practical requirements by having a favorable extension, it will undoubtedly have great glamour. Take GIS industry as an example. Because there are different department managements, the used GIS data types are various, and business process is complicated and changeable, every department must develop their own special GIS software, which is the key reason why GIS secondary development is widely accepted and practiced. If developers must build every new application project from the very beginning, it will undoubtedly waste intelligence, experience and precious time. While using plug-in application framework can fully solve these problems[1].

Environmental on-line monitoring can be divided into environmental quality monitoring and serious pollution monitoring. Environmental quality data monitoring mainly consists of water quality automatic monitoring station, environmental air automatic monitoring station, urban smoke monitoring video, environmental quality automatic monitoring center and ecology environment quality observation station. Monitoring data is urban key pollutants. Environmental on-line monitoring management system covers on-line instrument monitoring, data communication, data base construction and information management software development and so on. The core lies in collecting effective and reliable environmental information and raising the utilization rate and share degree of the environmental information by the means of advanced information technology to provide timely and scientific basis for environment monitoring and management.

In terms of demands of environmental on-line monitoring system, the collation, display, inquires and

between special data and attribute data is the key to system establishment. So need to introduce GIS management function. The functions of GIS in environmental on-line monitoring are as follows: providing access and management function for spatial data and relevant attribute data. Environmental on-line monitoring system needs to process quickly lots of spatial data and attribute data. While GIS provides fast integrated process and management ability for spatial data and attribute data to meet the needs for inquires, update, statistics, module analysis and prediction of kinds of monitoring data.

GIS also can provide various kinds of monitoring data source layers and displayed directly in electronic map. The system connects the main monitoring information and GIS platform and display the monitoring situation of main pollutants in the thematic map of environment. Additionally, it provides interactive query between spatial data and attribute data. The two-way interactive function of GIS can make the users to inquire the operation situation about sewerage and situation about monitoring equipments fast and conveniently. What's more, the surrounding nature and social environments situations can be inquired relevantly. It provides spatial analysis function for monitoring data. Dynamic superimposed pollution sources, rivers, settlements and other key layers produce many kinds of professional analysis data and issue on-line data in real-time. On one hand, monitoring data accesses the map through the browser, and display real-time monitoring results directly on the map. On another hand, monitoring data can display monitoring reports on the web page directly through inquiring GIS interface.

Overall design of the system should adhere to the structure idea that the data, management, services and application should be separated. On the basis of keeping the flexibility and expansibility, realize the management and sharing of fundamental spatial geography data, realize the integration, sharing and exchange of existing resources data, realize the integration and comprehensive application of existing system services, realize the integration with CA authentication system.

System framework consist six levels and two systems. They are spatial basic network level, data level, services level, application level, security authentication level, display level; spatial information resources security guarantee system and spatial information resources management system respectively.

Data level: spatial basic information network level includes existing environmental monitoring network, host computer and storage equipments. It is the communication basis of spatial basis information platform, is the veins of spatial basic information data center. Its function is to connect each agency's geographic spatial database into loose coupling system (namely, decentralize physically, and be as a whole logically).

Service level: service level includes spatial data catalogue service, spatial basic data service, spatial data analysis service, spatial data exchange service and meta-data data service. Service level uses GIS platform engines to obtain spatial data and issue spatial data according to WMS/WFS standards of DGC. The services the users obtain through WebService methods are: catalogue service, meta-data service, remote sensing image service, digital elevation model service, topographic map service, vector map, urban three-dimensional landscape service and even data download service.

Application level: application level integrates the data service provided by service level and establishes comprehensive application facing diverse subjects.

Security authentication: security authentication mainly ensures the system data's access security, and can be connected with CA authentication platform.

Display level: display level establishes connection between extranet and intranet of government affairs and internet through environmental network. And it contributes in publicizing for the government, enterprises and the public.

2.2 Plug-In Technology of ArcEngine

by ArcGIS Engine to operate independently without the support of ArcGIS Desktop and it is a secondary development functional component package to be used in developing new GIS application program. It fully supports plug-in technology[2]

Logically, there are five parts in the components of ArcGIS Engine’s component library, that is, Base Services, Data Access, Map Presentation, Developer Component and Extensions. Base Services includes the core component ArcObjects in ArcGIS Engine. Data Access contains all the interfaces and class components of GeoDatabase for accessing grid data or vector data. Map Presentation contains the components[3] of GIS application program to be used for data display and data symbolic. Developer Component contains all visualized controls needed for rapid development, such as SymbologyControl, GlobeControl, MapControl, SceneControl, TOCControl, ToolbarControl and the like. Extensions contains many advanced functions such as space analysis, network analysis and data interoperability.

The close integration between ArcGIS Engine9.3 and Visual Studio .NET 2005 provides many IDE plug-ins to integrate with Visual Studio .NET 2005 closely and enables it easier for developers to edit ArcGIS Engine program based on Visual Studio .NET 2005

3. The design and implementation of plug-in GIS application framework platform

3.1 The design of Plug-In Framework Host Program

The platform is a pluggable and extendable system. The reason for plugging is to guarantee the normal communication between the system and the plug-in by relying mainly on some core objects. The class relation figure of the design of the system is shown in diagram 1.

FrameworkClass, ApplicationClass and BarManagerClass contain mutual interface for each other, namely, another object instance may be acquired or set up conveniently through an object instance. These three core interfaces and classes constitute the core of the platform.

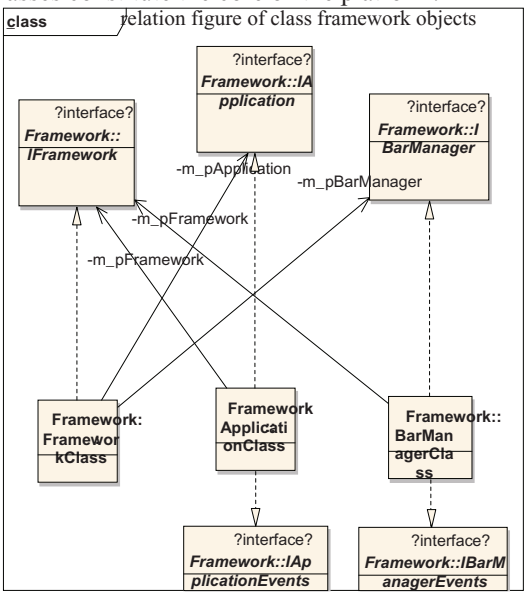

Figure 1 Framework Core Class Relation Figure the System Design

Another major component of plug-in framework is plug-in object. Plug-in is a leading role in application framework and executor in function extension, which is the part the users concern most. Each function contained in plug-in platform such as menu bar, toolbar, right menu, command line and shortcut key are managed by the platform in a manner of plug-in.

a) The Design Specification Of Plug-in

The host program in the plug-in application framework does not know what plug-in objects it would deal with, or even has no ideas to introduce the plug-ins types statically using key words. Not until it is operating can these information obtained. Under this new condition, we can not produce a new type of object by static means and new key words. Instead, we need to use other ways to load program sets dynamically and acquire relevant type of information in program sets while it is operating. This requires our plug-ins must comply with unified specifications, that is, interface specification, code specification and configuration specification.

Interface specification: the interfaces provided to the plug-ins are all in component Desktop.Framework. All plug-ins must realize interface ICommand or ITool Under the usual circumstance, plug-ins are derived from BaseCommand and BaseTool provided by ESRI. Plug-ins of button type must realize interface IBarButtonItem. Plug-ins of edit control type must realize interface IBarEditItem. Plug-ins of static text type must realize interface IBarStaticItem. Plug-in of right menue supporting the map type must realize interface IToolContextMenu, right menue supporting TOC must realize interface IControlContextMenu and plug-ins supporting short cut keys must realize IShortCut.

Code specification: change type of IHookHelper into IHookHelperEx type, HookHelperClass into HookHelperExClass and what the attribute Hook saves is actually the quote of the current application program object; setting up filed of m_caption or overriding Caption attribute may change the title of the plug-ins displayed on the interface; setting up the filed of m_caption or overriding ToolTip attribute may change the prompting message of plug-ins displayed on the interface; overridding the attribute of Enabled or setting up the availability of the functions according to the current state of object hookHelper directly results in that whether corresponding buttons of the functions can be used or not.

Configuration specification: in the platform, plug-in is based on XML configuration files. A plug-in configuration file is contained in every main desktop program. They are MapUI.xml——plug-in configuration file of map; LayoutUI.xml——Layout's plug-in configuration file；CatalogUI.xml——Catalog's plug-in configuration file. All such configuration files comply with the same configuration specification shown as follows:

〈?xml version= "1.0" encoding="utf-8"?〉

〈interface element〉

〈menu row= "0" line= "0" name= "main menu" display= "Ture"〉

〈Tool name = "File" title= "document" short cut key= "Alt+F"〉

〈Tool name= "NewDocumentCommand" title= "new blank mapping text…" Class= "PluginLib. Main. NewDocumentCommand" Path= "PluginLib.Main.dll'/〉

〈Tool name= "NewDocumentCommand" title= "opening mapping text…" Class= "PluginLib. Main. NewDocumentCommand" Path= "PluginLib.Main.dll'/〉

〈Tool name= "NewDocumentCommand" title= "saving mapping text…" Class= "PluginLib. Main. NewDocumentCommand" Path= "PluginLib.Main.dll'/〉

〈 Tool name= "NewDocumentCommand" title= "saving as…" Class= "PluginLib. Main. NewDocumentCommand" Path= "PluginLib.Main.dll'/〉

〈 Tool name= “NewDocumentCommand” title= “exiting” Class= “PluginLib. Main. NewDocumentCommand” Path= “PluginLib.Main.dll’/〉

〈/tools〉

In the child nodes of the “interface elements”, there are “menu bar” nodes and several “toolbar” nodes. What the “menu bar” nodes configure are the plug-ins of the main menu in application program. And what the several “toolbar” nodes configure are the plug-ins of each toolbar of the application program. Nodes of “menu bar” and “toolbar” contain child nodes of “tools”. And nodes of these “tools” also contains chide nodes of “tools”. This is a recursive tree structure.

b)Dynamic Loading and Object Generation Of Plug-In.

After completing all necessary plug-in interface and plug-in containers in design, we use the information provided by Assembly in NET Framework to achieve the dynamic loading of plug-ins, namely reflection mechanism. After starting plug-in application framework, plug-in engine will pass through every program set in plug-in files and then load every program set and analyze every type contained in the program set by Assembly class. Only after recognizing some type is legal, can the plug-in engine generate an instance object according to the type of the information and put the plug-ins into containers for standby.

Plug-ins are classified into command plug-ins and tool plug-ins. Command plug-ins: no interactive exists between developed plug-ins and map controls. This plug-in must realize interface ESRI.ArcGIS.SystemUI.ICommand or must be derived from BaseCommand class; tool plug-in: interactive exists between the developed plug-ins and the map controls. this plug-in must realize interfaces ESRI.ArcGIS.SystemUI.ICommand and ESRI.ArcGIS.SystemUI.ITool or must be derived from BaseCommand.

This framework can load dynamically two types of plug-ins: one is .net plug-ins and the other is .complug-ins. So many developmental tools can be used to develop the plug-ins, i.e. C#、VB.NET、vb、vc and so on. The developed .net plug-ins and the command class developed in the forms of com components need to realize interface ICommand. While the tools which need to realize interactive operation with map controls need to realize interfaces ICommand and ITool at the same time

3.3 The Implementation of Function of Plug-In Application Framework Platform

Plug-in application framework platform consists of three parts, i.e. basic framework, basic tools and expansion tools and it has such main functions as data browse, data edit, data management, version management, topology, inquiring and statistics, spatial analysis, symbolic edit, thematic map, catalogue tree, seizing, composing points tools, Element tools, mapping tools and so on. Main interface of plug-in application framework platform is shown as follows:

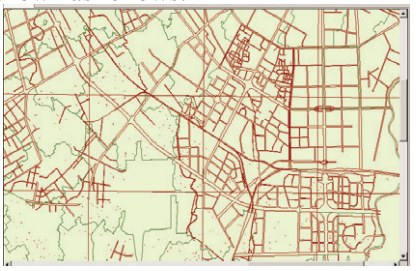

Figure 2 Main interface of plug-in application framework platform

Software framework is designed for multiplex. The development of application software is actually the expansion and instantiation[4] of software framework during the software development based on the framework. Full plug-in GIS application framework aims at achieving the unified development pattern of different platform GIS and the multiplex of level modules, simplifying the developmental course and improving developmental effectiveness through full plug-in system and structure as well as the standardized GIS interface. The plug-in application framework platform introduced in this thesis adopts plug-in GIS application framework on the basis of secondary development by selecting ArcGIS Engine component lib. It is not concerned with specific business process. It is only a pure GIS framework for data display and function support, a software platform to browse and edit geographic data. It establishes a plug-in GIS application framework through components libraries NET 2.0 Framework and ArcGIS Engine9.2. The platform adopts visualized dragging and dropping components to assembly and complete GIS application integration by the means of adopting dynamic plug-in loading configuration, thus, greatly simplifying the complexity of the application integration, decreasing greatly the developmental difficulty of the enterprises GIS application integration and effectively improving the availability and operability of the GIS application system. To some degrees, although the appearance of this new type of developmental platform promotes the development of GIS software industry and application undertakings in our country, it remains a long time effort to promote the real GIS development. Change the original excessively specialized developmental method into a developmental tool that more developers can grasp in order to make it a more popular application field.

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